American Samoa Vegetation Mapping
Using Very High Spatial Resolution Imagery

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Methodology

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Introduction

The USDA Forest Service Pacific Southwest Region, Forest Health Protection (FHP) and the Pacific Northwest Research Station, Forest Inventory and Analysis (FIA) Programs are leading a collaborative effort to acquire recurring high spatial resolution satellite imagery and develop detailed vegetation maps for the U.S affiliated Pacific Basin islands. The long-term goal of the program is to provide environmental scientists and resource managers with up-to-date information on land cover and its change through time. This report provides detailed documentation of the methods and techniques used to create the vegetation maps for American Samoa. Islands mapped include the main island of Tutuila, the Manu'a Islands of Ofu, Olosega, and Ta'u, Roas Atoll and Swains Island.

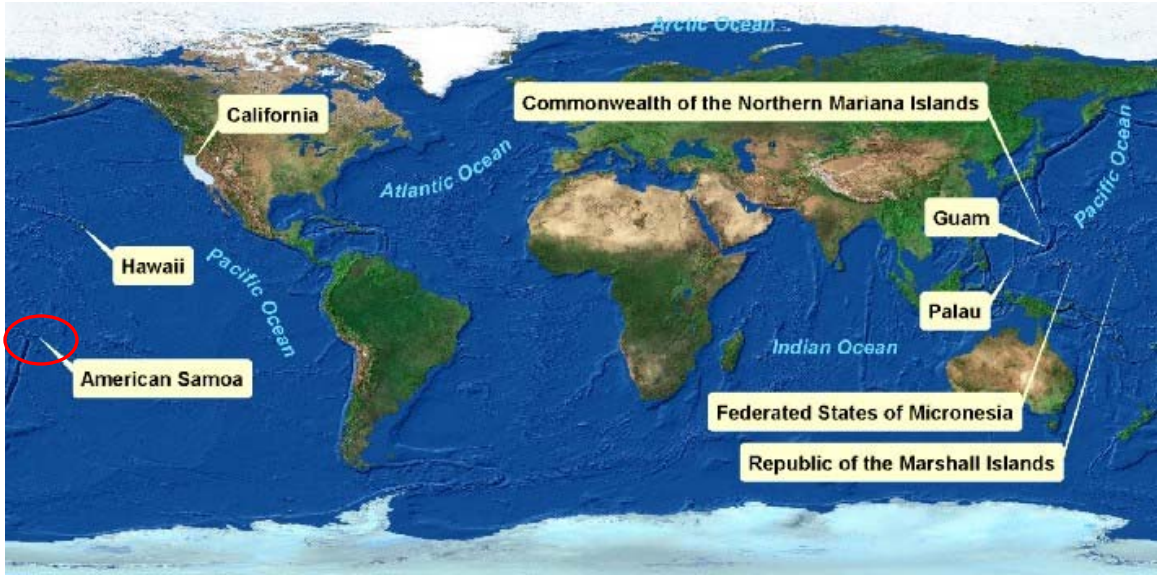

Figure 1. Geographic location of American Samoa

Project Area

American Samoa is an unincorporated territory of the United Sates. Located in the South Pacific Ocean just east of the International Date Line, this group of Polynesian islands are about 4,200 km south-southwest of Honolulu. The total population of American Samoa was 57,291 according to the 2000 census data (U.S. Census Bureau, 2000). The island of Tutuila (52.5 sq. mi) is the governmental and economic center and home of vast majority of the population. Tutuila and the Manu'a Islands of Ta'u (17.6 sq. mi), Ofu (2.8 sq. mi) and Olosega (2.0 sq. mi) are all high volcanic islands with only narrow strips of relatively flat land on the coastal and rugged, mountainous interiors. Rose and Swains are very two small low-lying atolls. Rosa, only 8 ha in size, is an uninhabited atoll with two tiny islets. The Swains Island (1.4 sq. mi), on the other hand, is a raised atoll with a large enclosed lagoon. It used to have a copra export production that has already ceased operation. The highest point in American Samoa is Mt. Lata (965m) on Ta'u Island. The highest point on the main island of Tutuila is Mt. Matafao (653m).

The climate of American Samoa is warm and humid, with a mean annual rainfall of 5080mm and precipitation occurring on an average of 300 days per year. The rainy season runs from November to March. The relative dry season goes from June to September. Its average annual temperature is 26 degrees Celsius (79 degrees Fahrenheit).

Classification Scheme

The mapping scheme for American Samoa islands was created based on information available in *Vegetation of the Tropical Pacific Islands* by Mueller-Dombois and Fosberg (1998) and from the Forest Service vegetation survey report, *Vegetation Survey and Forest Inventory, American Samoa*, by Thomas G. Cole et al. (1988). The complete list of classes and the cross-walk to the classes used by the historic vegetation survey (Cole, et al., 1988) can be seen in Table 1 below.

New Class	Historic Class
Dwarf Forest	Dwarf Forest
Montane Rainforest	Upland Forest
Lowland (Tropical) Rainforest	Upland Forest
Rain Forest	Upland Forest
Coastal Forest	Coastal Forest
Mixed Forest (Rosa & Swains)	N/A
Modified Forest/Disturbed Lowland Tropical Rainforest	Agroforest/Secondary Vegetation
Secondary Forest	Agroforest/Secondary Vegetation
Littoral Vegetation	Strand
(Lowland) Shrub/Grass	Secondary Vegetation
Mangrove	Mangrove
Marsh	Marsh
Urban/Developed Land	Urban
Barren/Cleared/Sandy Beach and Bare Rocks	Barren
Water	Water
Clouds and Shadow	N/A

Table 1. Classification scheme for American Samoa

Imagery Data

IKONOS (Space Imaging ®) 4-meter resolution multispectral and 1-meter resolution panchromatic images were the source data for this mapping project. The data was provided by the USFS, Pacific Northwest Research Station, Forest Inventory and Analysis Program (FIA), and Pacific Southwest Region, Forest health Protection Program. Table 2 details the data specifications.

IKONOS Image	Band	Spectral Range (micrometers)
1-meter Black-and-White	Panchromatic	0.526 ~ 0.929
4-meter Multispectral	Band 1 (blue)	0.445 ~ 0.516
	Band 2 (green)	0.506 ~ 0.595
	Band 3 (red)	0.632 ~ 0.698
	Band 4 (near infrared)	0.757 ~ 0.853

Table 2. IKONOS Data Specifications (Space Imaging, 2004)

When mapping tropical island vegetation using satellite imagery, one of the most challenging issues is cloud cover. Most satellite sensors including IKNONOS cannot penetrate clouds thus will leave large areas (under clouds or in shadows) with no valid image data to extract landcover information. Figure 2 through 5 are the false-color composites (Red:Green:Blue = NIR:Red:Green) of the IKONOS images for the four larger American Samoa islands: Tutuila, Ofu, Olosega, and Ta'u. All of these islands have clouds.

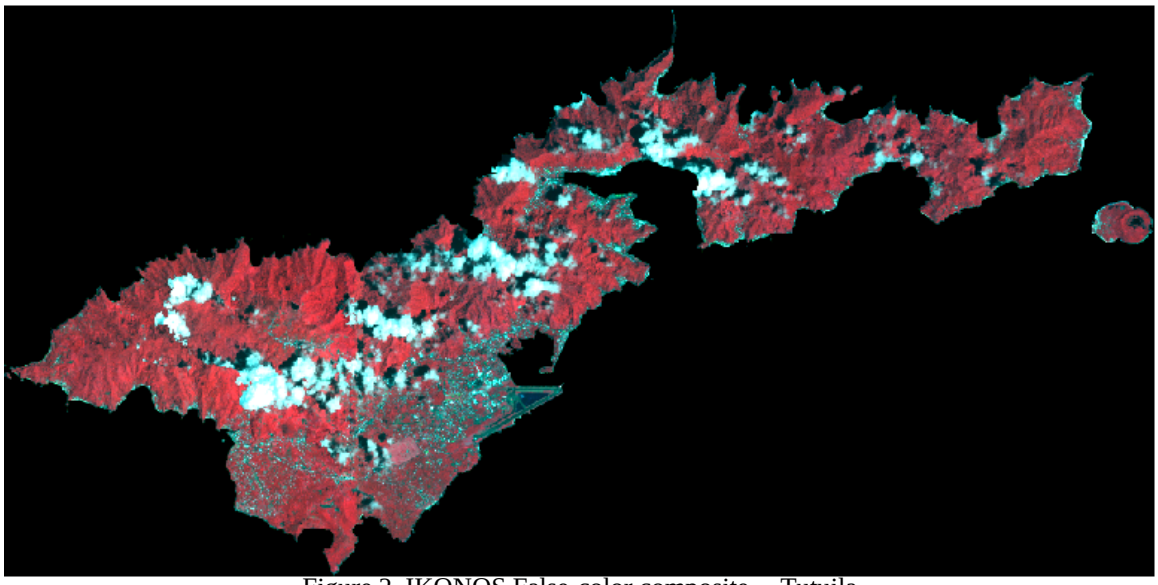

Figure 2. IKONOS False-color composite -- Tutuila

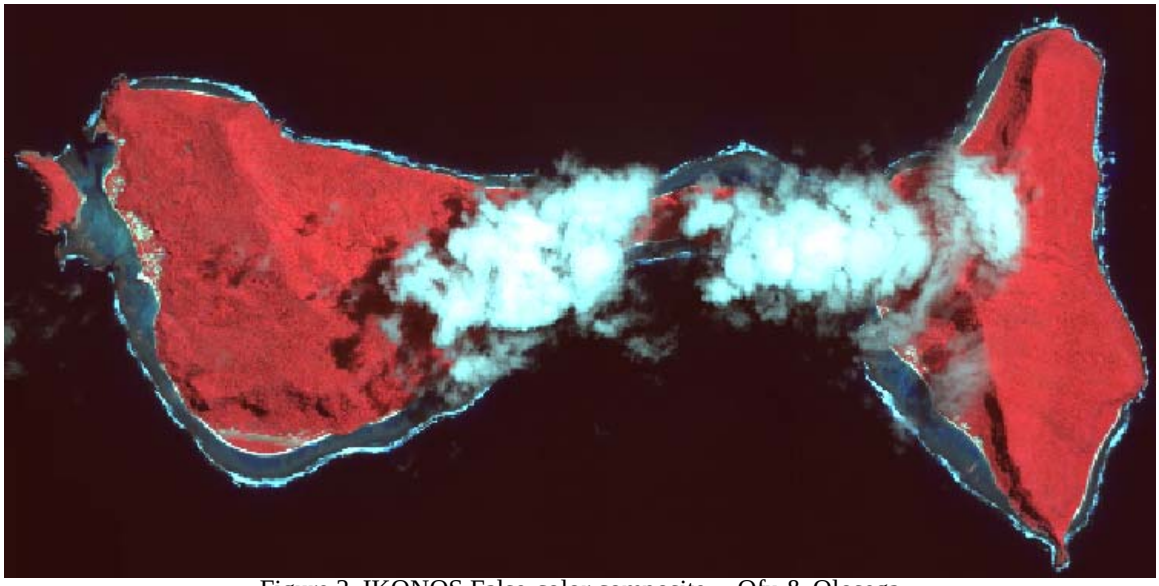

Figure 3. IKONOS False-color composite -- Ofu & Olosega

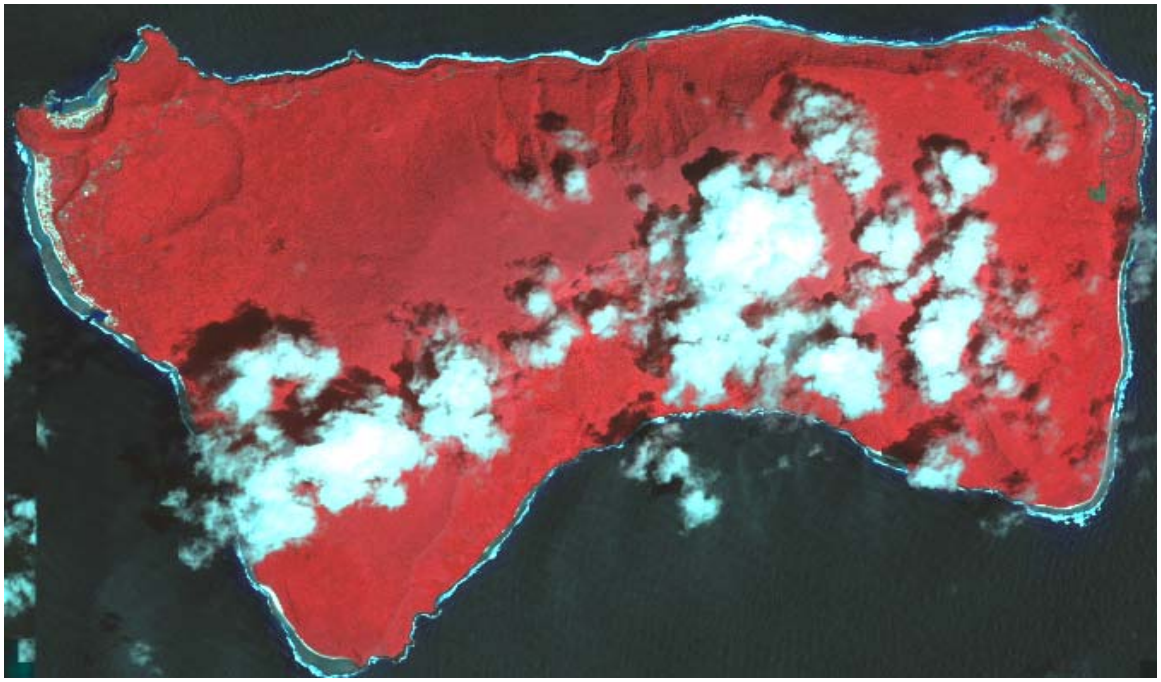

Figure 4. IKONOS False-color composite -- Ta'u

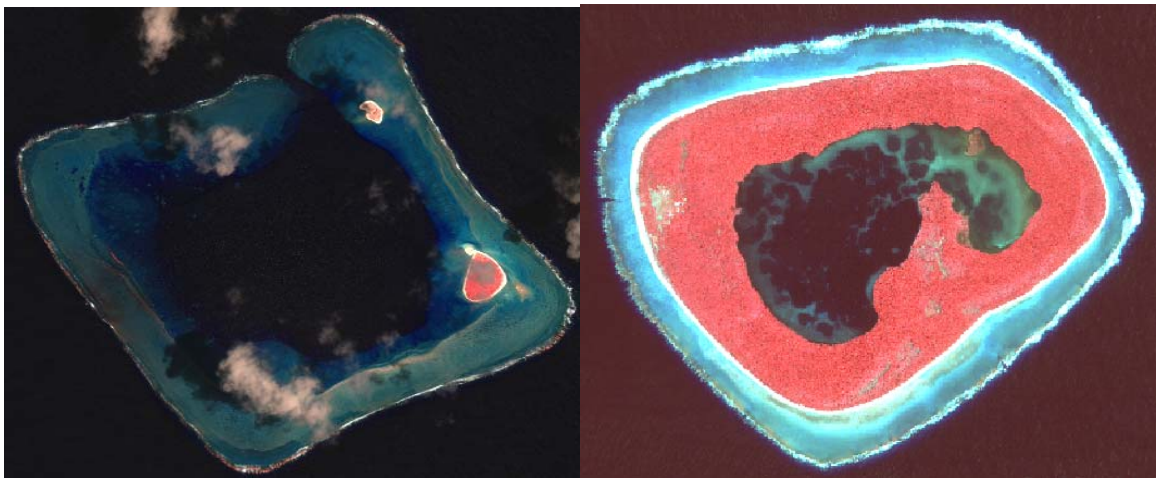

Figure 5. IKONOS False-color composite – Rose (left) and Swains (right)

Image Processing and Classification

Two methods were used to classify the vegetation on these islands including a simple unsupervised classification, and an object-oriented image segmentation with visual interpretation for class labeling.

A mosaic was developed for the island of Tutuila by co-registration and radiometric normalization of four IKONOS scenes. Clouds were manually delineated and masked out of the mosaic image.

An unsupervised classification was performed and classes were labeled based on the established classification scheme (Table 1). The 1-meter resolution black-and-white panchromatic image and the historic vegetation survey maps were also used to help label classes.

The labeled classification map was manually edited and filtered to a minimum mapping unit of 50 pixels (about 1/5 acres).

Historic vegetation survey data was used to "fill in" areas covered under cloud which were masked out and excluded from the classifications.

Object-oriented image segmentation and visual interpretation

An unsupervised classification was also performed on Ofu, Olosega and Ta'u, but did not yield sufficient results due to severe cloud and shadow effects. Therefore, a combined object-oriented image segmentation and visual interpretation and labeling method was used for these islands. Swains and Rose were simply too small to require additional automated analysis.

Clouds and shadows were delineated and masked out prior to running an unsupervised classification on the 4-meter resolution multispectral IKONOS images and preliminary class names were assigned.

The 4-meter resolution multispectral images were next fused with the 1-meter resolution black-and-white panchromatic images to create 1-meter resolution multispectral pan-sharpened images.

The 1-meter resolution pan-sharpened images in GeoTiff format were then segmented using eCognition (Pro. 4.0 version, Definiens ®) to create base polygon layers. Scale parameter of 50 was chosen for the segmentations based on previous experience.

All polygons on the base layers were labeled according to the established classification scheme using customized tools in ArcMap 8.3 (ESRI ®). The preliminary unsupervised classification results and historic vegetation survey maps were used as references during this process to help identify the vegetation classes. Pan-sharpened natural-color QuickBird images with a spatial resolution of 60-centimeter, when available, were also used to assist the visual interpretation.

As the last step, maps were filtered to a 0.25-acre minimum mapping unit to produce the final product.

*(*final maps in PDF formats ready to be inserted)*

Summary

The high-resolution IKONOS imagery (4-meter resolution multispectral and 1-meter resolution panchromatic) can be used as an effective source for mapping the vegetation of the islands of American Samoa. Heavy cloud/shadow is a major challenge when mapping in this environment. Continued data acquisitions may help to remedy this problem.

Data Distribution

Final vegetation data is released in ESRI shapefile vector format. Final layers are checked for topology errors, corrected if detected, and attribute tables were standardized. Sample symbology layers for displaying the data in ArcMap software are created. FGDC-compliant metadata files are provided using tools provided in ArcCatalog (ESRI ®). The final distribution package includes the vector data and other documents is downloadable through the FHP website at http://www.fs.fed.us/r5/spf/fhp.

Acknowledgments

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